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THE FOOD HABITS OF THE YELLOWFIN TUNA (Neothunnus)

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THE FOOD HABITS OF YELLOWFIN TUNA *NEOTHUNNUS MACROPTERUS* (SCHLEGEL) FROM THE CELEBES SEA

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Pacific Oceanic Fishery Investigations

1/ From the Transactions of the Natural History Society of Formosa [Taiwan Hakubutsu Gakkai Kaihō], Vol. 26, No. 148, January 1936. pp. 1-8.

A study was made of the food habits of the yellowfin tuna taken by the research vessel Shōnan Maru of the Taiwan Government-General Fisheries Experiment Station in the course of exploratory fishing in the Celebes Sea.

The stomachs were removed from the fish immediately after they were caught and were preserved in formalin. In order to prevent the loss of any of the stomach contents each stomach was placed separately in a bleached cotton bag. Collections were made at two different times, in February 1933 and from July to September 1934. Stomachs from a total of 57 fish were collected, 34 on the first voyage and 23 on the second.

The fishing grounds were as shown in Figure 1. It can be seen that, except for a part of the stations, these two exploratory fishing cruises were carried out in exactly the same waters. As a result, although they were not both made in the same year, the study can be regarded as providing an opportunity to compare results from collections made at two diametrically opposite seasons of the year.

The materials for this study were obtained through the kindness of Mr. Hitoshi Hiratsuka, who was in charge of operations aboard the ship at the time. My profound gratitude to him is here expressed.

In discussing food habits it is thought that there will naturally be some argument about the matter of basing such a study solely on stomach contents, but it is believed that they have much value as data for reference.

The stomachs were cut open and all of their contents emptied out into a dissecting pan for inspection. The results of that examination are shown in Figure 3.

The number of times of appearance was counted as the number of stomachs in which a particular item appeared without any regard to the number of specimens contained in the stomach. The number appearing is the total number of specimens of each species which was found in all of the stomachs. Consequently the number of times of appearance and the number appearing are not necessarily the same nor even correlated.

The reason for the adoption of this distinction is that the items which appear in large numbers may not in some cases necessarily be important foods, and the opposite case may also be true, while those items which appear both in a large number of cases and with a large number of specimens may be thought to be the important foods of the yellowfin tuna.

The greatest difficulty in this work was the frequent appearance of species of fish which, because of the progress of digestion, could not be accurately identified. If we examine the progress of digestion as it applies to fish, it appears that first of all the skin is completely digested and the eyes are lost. The muscles should be next to be digested, but it is interesting that in many cases the head is destroyed and separated from the body while the muscles are still not fully digested. The skeleton and other tissues appear to be broken down separately, and in many cases the skeleton is rolled up in a ball and lodged near the pylorus. It is not known whether this digestive detritus (bones and other undigested material) passes on down through the intestine or whether it is expelled by regurgitation, but at any rate it is interesting that in the stomach the skeletal parts undergo this process and end up in a mass in one part of the stomach. It is not possible to tell without examining the intestines, but it may be that these materials are regurgitated.

Large items of food which can not fit into the stomach as they are, for example scombroids, needlefish, halfbeaks, barracuda, and so forth, are put away bent double. From the shape such fish are in it cannot be determined whether they were swallowed head first or tail first.

In many cases where, as described above, the heads are lost but the bodies are still comparatively whole a basis is provided for making a count of the number of individuals.

It is not known whether or not there is a point of satiation in the feeding of the yellowfin, but in fish which may be thought to have eaten well one may find in a specimen 137 cm in length three specimens of Auxis sp. about 30 cm in length along with various other items.

A total of 3 fish, 2 on the first cruise and 1 on the second, were taken with their stomachs completely empty. This is somewhat over 5% of the whole number of specimens.

It is a question whether or not the yellowfin is fully capable of selecting its food because, as will be related below, when they are feeding on demersal forms one sometimes finds pebbles, decayed leaves of trees, and so forth in the stomachs. These cannot be considered to have any significance as food for the yellowfin, and are judged to be clearly matter which has entered the stomachs together with the bottom-dwelling organisms.

The following paragraphs are in explanation of some of the terms used in Figure 3.

The unidentifiable fish are those in which it is only possible to tell by the skeletal remains that they are fish, but in which it is impossible to tell what kind of fish they are. Consequently the number of specimens cannot be determined either.

Unidentifiable matter is that concerning which it is absolutely impossible to tell whether it is of animal or vegetable origin or whether it is detritus from the sea-bottom.

Cases were frequently met with in which, although the family name of the specimen was known, the genus and species could not be ascertained, and in such cases we were forced to identify the specimen only by the family name. For example, the fishes of the family Carangidae are all lumped together under the designation "carangid". However, where the generic and specific names are known the specimens are treated separately.

The following is a general consideration of the food habits of yellowfin tuna in the Celebes Sea.

The most important natural food of yellowfin tuna in the Celebes Sea is fish, followed by mollusks (principally squids), with crustaceans, jellyfish, and so forth also appearing in the stomach contents. A more detailed examination, however, reveals that squids are the most important single item of food. It is thought that all of the squid are of one species, perhaps the tobiika [Symplectoteuthis ovalaniensis] (?), but in so many cases the head and tentacles were missing or digestion had proceeded to such an extent that it was impossible to determine the species.

Among the fishes those which appeared most commonly were Engraulis, Ostracion, listes, Sphyraena, Tylosurus, Stolephorus, Scombroid [sic], and Leiognathus.

The above are all either pelagic, or, if they are shore-dwelling species, they ve the characteristic of moving about accompanying floating driftwood, so it is t strange that they should form part of the food of yellowfin tuna. It can only said that on the score of the number of stomachs in which they appeared and the mber of specimens which were found the results were different from what had been ticipated.

It was said that in the course of investigations in the field flyingfish ap- ared from time to time, but in my investigation not a single specimen was found.

Along with these food items were some crustaceans which were plentiful both in umber of appearances and number of individuals and which were all bottom-dwelling rms. This fact is probably related to some extent to the position of the fishing ounds, but it can serve as evidence to show that yellowfin have the characteristic hunting food on the bottom at times.

When these demersal forms were found, as mentioned above, there were also ound a large number of pebbles of about one centimeter in diameter along with the ecayed leaves of trees. From this it is thought that the yellowfin migrates much loser in to the shallow coastal waters than had been expected, however, it is not fficult to imagine that this is true in the case of small islands far out in the ea where the effect of the land mass on the sea water would be extremely slight.

Among the purely planktonic forms found in the stomachs of the yellowfin there ere some jellyfish, but the number of appearances and the number of specimens were mall. Judging from the aforementioned point about the doubt which exists as to he powers of food selectivity of this fish, it is a question whether or not the ellowfin ate these jellyfish consciously. Perhaps they were swallowed accidentally long with other small fish.

It was mentioned above that there is probably some relation between the posi- ion of the fishing ground and the food habits of the fish. This is what one would aturally imagine, and in view of the fact that the yellowfin tuna is to begin with rather omnivorous animal, there is no room for doubting the truth of the assertion.

On the first cruise there were five fishing stations at which the fish had aten large numbers of bottom-dwelling organisms; these were stations VIII, X, XII, IV, and XVI. The same was true of eight stations, I, II, III, VII, IX, XIX, and XIV, on the second cruise. It is unfortunate that there was no material from tations IV, V, and VI of the second cruise, but the stations of the first cruise hich are listed above and stations I - VI of the second cruise were all located round Karakelong Island or close in to other islands. Furthermore, the rest of he stations of the second cruise for the most part present characteristics approxi- ating these conditions. For this reason it may be said that the same sorts of henomena appeared in the same sea area or in sea areas presenting the same kinds f conditions. In other words, one may regard food habits as being controlled by eographical considerations.

In this way it was possible through a study of its food habits to gain some nowledge of the yellowfin tuna's vertical movements (?). If it were possible to scertain the depths and environmental conditions in which these demersal organisms ive, we could probably further enlarge our knowledge of the interesting habits of he yellowfin tuna.

The above is a generalized view of the food habits of the yellowfin tuna of the Celebes Sea. In what follows a brief record will be made of some of their peculiarities.

On both cruises specimens of the sabahii, Chanos chanos (Forskål) appeared from time to time in the record, but it should not be thought that these are natural food. The bait fish which the Shōnan Maru used in the experiment were sabahii read in southern Formosa. The specimens of this fish which appeared in the stomachs of the yellowfin should rightly be considered to be bait fish which the tuna swallowed as is shown by the fact that these fish were hardly digested at all.

Small shore fishes like Monacanthus, Balistes, and Ostracion, which can hardly be thought to be pelagic, appeared in large numbers. One reason for this is probably that the tuna migrate in close to shore, however, these fishes are often seen accompanying drifting timbers and so forth and it is wondered whether this may not be the explanation of their appearing in such comparatively large numbers among the natural foods of the tuna. At any rate it is interesting to note that fishes of this kind are rather important as food for the yellowfin tuna.

Among the crustaceans the Palinuridae, Squilla sp., Scyllaridae, and a tenagaebi (Leander sp.) were seen, with the tenagaebi the most common.

It is remarkable that among the fishes an Apodes resembling the conger eel appeared once and two pipefish were found.

As stated above, the most common mollusks were squids, but it should be noted that many specimens of nautilus (?) also appeared. The fish in which these specimens were found were taken on grounds near the aforementioned Karakelong I.

The following is a discussion of seasonal differences.

Since the experiments covered only one voyage in each season and the material available for study were in the numbers detailed above, it may be inappropriate to use them to show seasonal changes, however, as was stated before, all but a part of the fishing stations were in exactly the same sea area and it is not therefore impossible to consider the marked differences between the results from the two cruises as being due to seasonal variation. For this reason the marked differences between the results from the two cruises will be here treated as seasonal variations. Of course, any time a more detailed survey is made in the future there will be plenty of room for corrections.

To take up the squid first, on the 1933 cruise, which was made during the season when the northeast monsoon prevails, squid appeared in the stomachs of the fish taken at all but one fishing station, but on the 1934 cruise, made during the southwest monsoon season, squid appeared at only 11 out of the 23 stations. This is considering the problem by fishing stations, but if we look at it from the point of view of the number of fish whose stomachs contained squid, in 1933 24 out of 34 tuna were eating squid, which is over 70% of the total, while in 1934, with 11 out of 23 fish eating squid, this percentage dropped sharply to less than 48%.

In 1933 a considerable number of anchovy (Engraulis) appeared in the material studied, but in 1934 they were entirely absent and instead a herring (Stolephorus) which had not appeared in the previous year's collections was found in some number.

The trunkfish (Ostracion) was remarkably abundant in 1933, but in 1934 it decreased markedly. At the same time there was a marked increase in the numbers of

triggerfish (Balistes) and filefish (Monacanthus) in the 1934 collections.

Appearances of crustaceans increased greatly in 1934, but it is wondered whether this increase, as well as that of the filefish mentioned above, may not have been due to the difference in the fishing stations rather than to seasonal variation.

Carangids did not appear in the 1934 collections at all.

No important change could be detected in the number of appearances of needlefish, barracuda, and so forth.

As for the larger fish, that is, the scombroid fishes, in 1933 they appeared only once and that was only one specimen, but in 1934 they appeared 8 times and the number of specimens reached a total of 13.

Well, these facts have been recorded as seasonal variations, but the occurrence of such violent changes in tropical, or rather in equatorial waters, cannot but be regarded as a little strange, however, it is thought that the fluctuations in the numbers of squid, anchovies, herring, scombroids, and so forth may probably be more properly ascribed to seasonal changes than to differences between the fishing grounds.

If after all these phenomena are due to seasonal rather than geographical differences, we can reach the interesting conclusion that it is possible, through a study of the food of the yellowfin tuna, to gain some knowledge concerning the migrations and population fluctuations of a part of the fauna of the Celebes Sea. Thus these data can serve not only for the investigation of the food and habits of the tuna, but also for the study of other problems.

(10-12-35)

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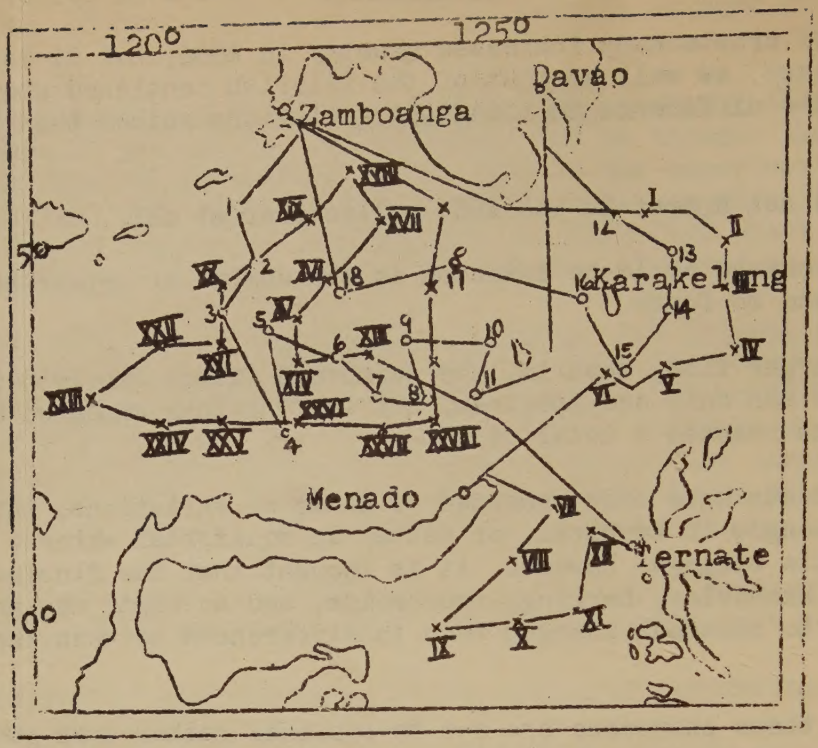

Figure 1 Chart of Fishing Stations

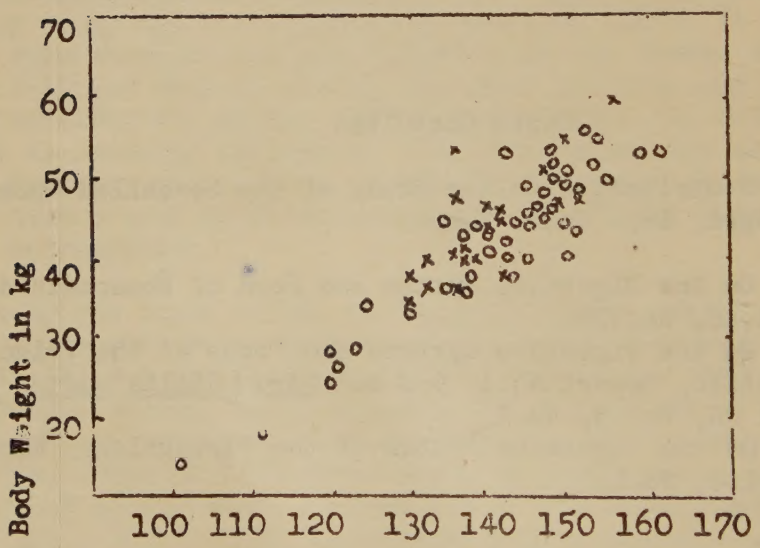

Figure 2 Sizes of the fish

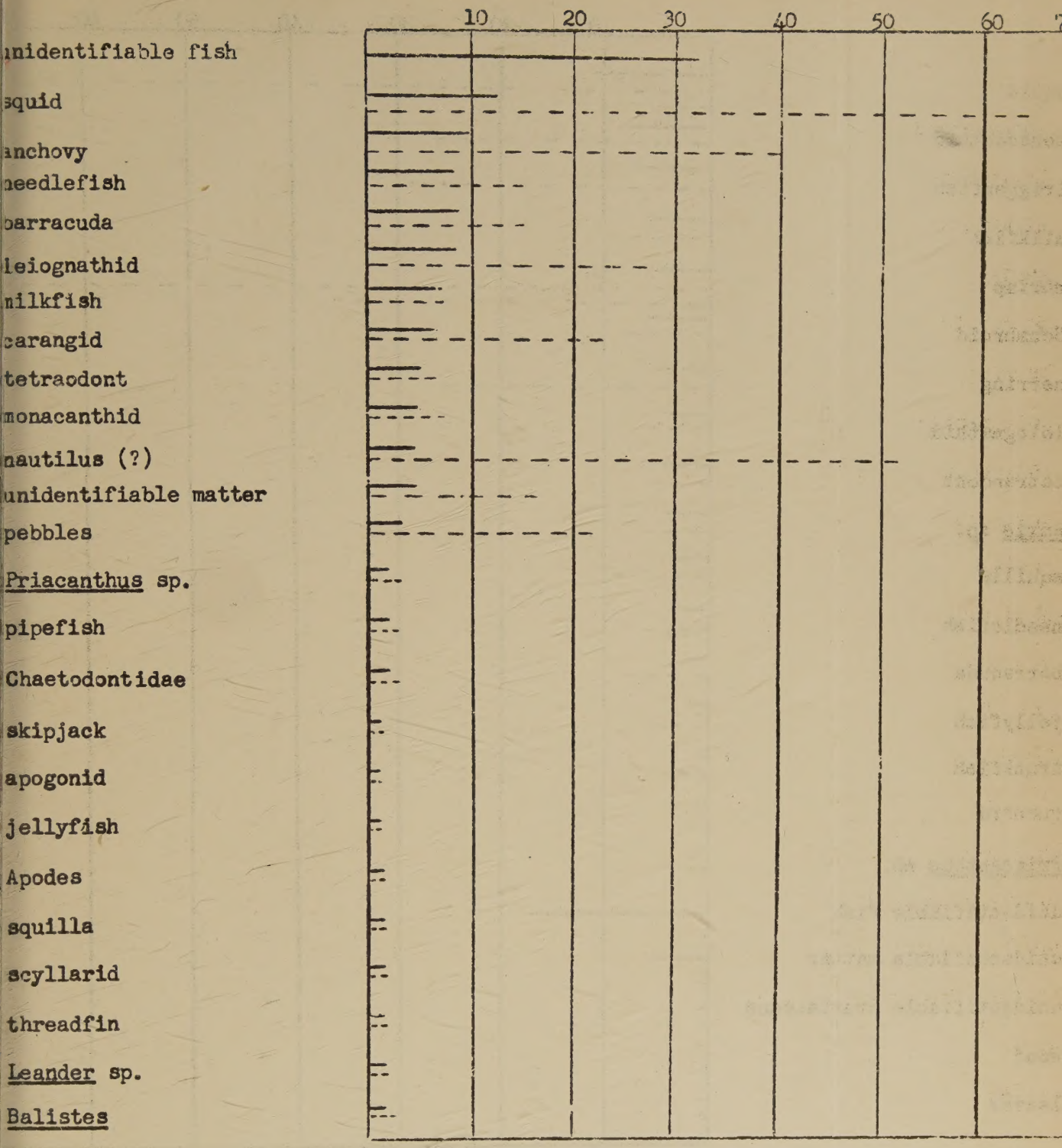

Figure 3a. Occurrence of Natural Foods, 1933

_____ number of appearances ----- number appearing

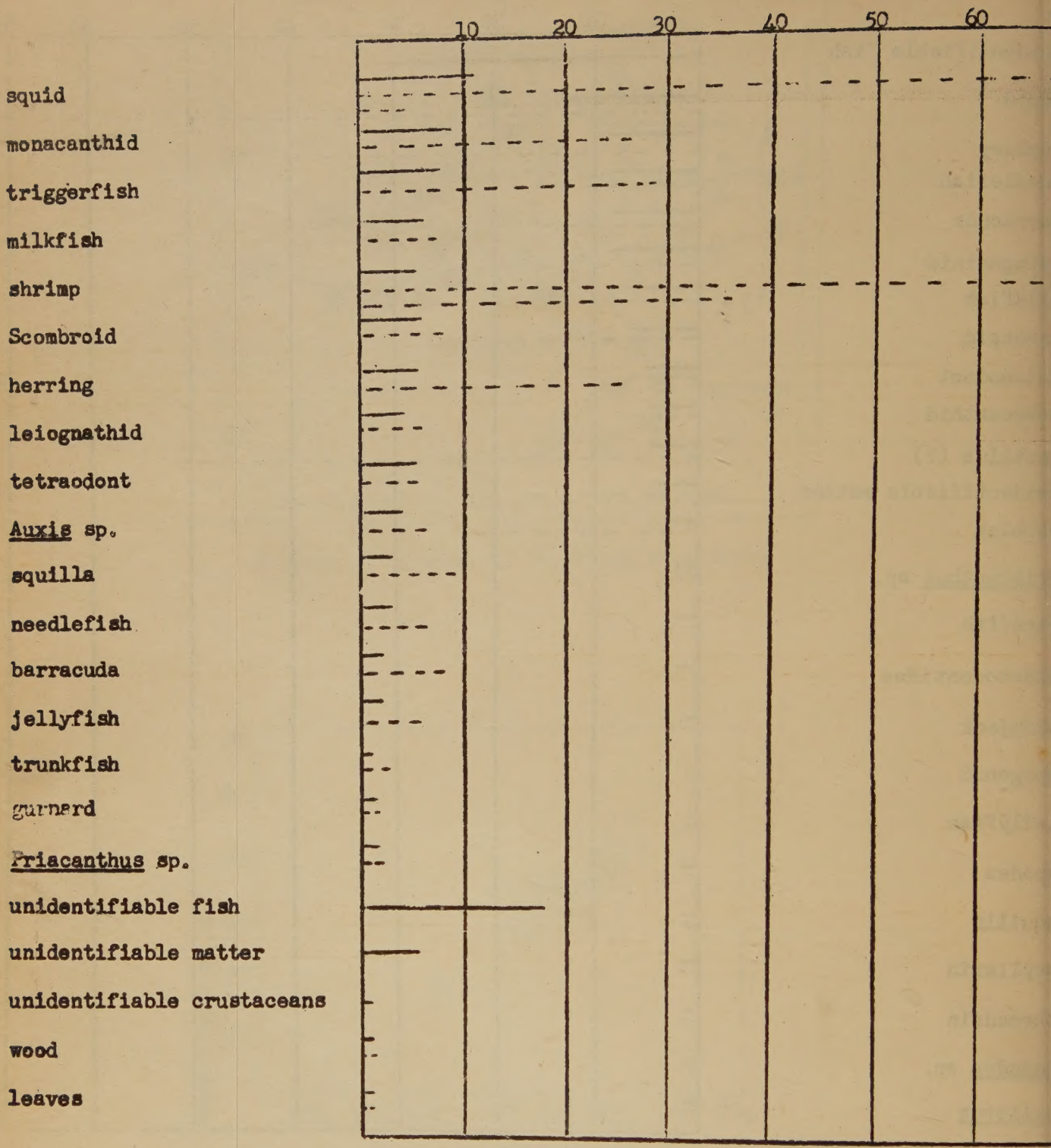

Figure 3b. Occurrence of Natural Foods, 1934

_____ number of appearances ----- number appearing

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